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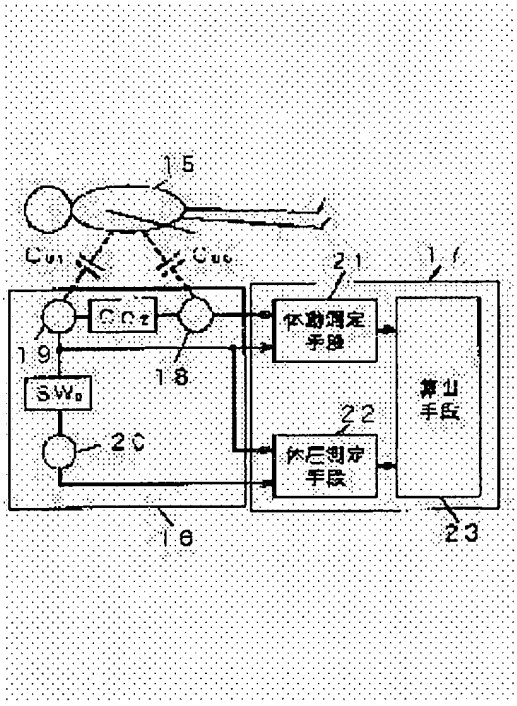
(71)Applicant : **MATSUSHITA ELECTRIC IND CO LTD**
(72)Inventor : **SHIMADA TAKUO**
**TAKESHITA SHIRO**
**KAWAI YOSHIYUKI**

## (54) VITAL SIGNAL SENSING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a vital signal sensing device which is for vital signals including body weight, heart rate, respiratory frequency, and physical motions non-inversively and non-restrainingly and which can perform automatic sensing accurately while the organism concerned remains unconscious of it.
SOLUTION: A vital signal sensing device concerned is equipped with a physical motion measuring means 21 to sense a dynamic signal based on the vital vibration connected with a single piece structured sensor sheet 16, which uses a common electrode 19, and a body pressure measuring means 22 to sense the static signal based on the body pressure of the organism concerned 15, whereby vital signals including body weight, heart heat, respiration, the amount of activity, the condition of the life, or the like can be accurately acquired without risk of misjudgement by synthesizing the outputs of the two means.

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* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] Biomedical signal detection equipment characterized by providing the following The 1st electrostatic capacity formed between the 1st electrode and a living body A body motion measurement means to measure the aforementioned living body's oscillating signal based on the series-connection electrostatic capacity of the 2nd electrode and the 2nd electrostatic capacity formed among the aforementioned living bodies A calculation means to be equipped with a body pressure measurement means to measure the body pressure accompanying a self-weight of the aforementioned living body by the pressure sensitive device between the above 1st or the 2nd electrode, and the 3rd electrode, and to compute the aforementioned living body's characteristic quantity further by the output of the aforementioned body motion measurement means and the aforementioned body pressure measurement means
[Claim 2] Biomedical signal detection equipment characterized by providing the following A body motion measurement means to measure the charge which formed the piezo electric crystal between the 1st electrode and the 2nd electrode, and was generated by a living body's vibration A calculation means to be equipped with a body pressure measurement means to measure the body pressure signal accompanying a self-weight of the aforementioned living body by the pressure sensitive device between the above 1st or the 2nd electrode, and the 3rd electrode, and to compute the aforementioned living body's characteristic quantity further by the output of the aforementioned body motion measurement means and the aforementioned body pressure measurement means
[Claim 3] the [ for the 1st, the 2nd, and the 3rd electrode being connected to the conductive layer of at least three layers, and each aforementioned conductive layer, and measuring a living body's body motion or body pressure between the 1st conductive layer and the 2nd conductive layer or between the 2nd conductive layer and the 3rd conductive layer / the 1st or ] -- the biomedical signal detection equipment according to claim 1 or 2 in which 2 detection medium layer was formed
[Claim 4] The 1st detection medium layer measures a living body's body motion, and the 2nd detection medium layer measures the aforementioned living body's body pressure. Biomedical signal detection equipment according to claim 3 which communalized one side of the electrode connected with one side of the electrode which was made to stick the 1st and 2nd detection medium layer, and was connected to the both-sides side of the detection medium layer of the above 1st in the both-sides side of the detection medium layer of the above 2nd.
[Claim 5] The 1st, the 2nd conductive layer, and a detection medium layer are biomedical signal detection equipment according to claim 3 or 4 which comes to constitute the sensor sheet of ****** which has flexibility and was really fabricated, respectively.
[Claim 6] A sensor sheet is biomedical signal detection equipment according to claim 5 characterized by having two or more air holes.
[Claim 7] Biomedical signal detection equipment according to claim 6 characterized by sticking a waterproofing film inside an air hole.
[Claim 8] Biomedical signal detection equipment [ equipped with a synthetic means to compound the output of the body motion measurement means concerned according to the output of two or more body pressure measurement meanses ] according to claim 5.
[Claim 9] Biomedical signal detection equipment according to claim 3 equipped with the elastic insulating layer from which thickness changes with pressures between the 1st conductive layer and the 2nd conductive layer.
[Claim 10] It is biomedical signal detection equipment [ equipped with the elastic insulating layer with porosity electrically connected with a pressure ] according to claim 3 between the 2nd conductive layer and the 3rd conductive layer.
[Claim 11] It is biomedical signal detection equipment [ equipped with the pressure-sensitive resistive layer from which resistance changes with pressures, such as an electrical conductive gum and electric conduction carbon, ] according to claim 3 between the 2nd conductive layer and the 3rd conductive layer.
[Claim 12] The claim 1 equipped with a body motion signal proofreading means to initialize the output of a body motion measurement means when the output signal or output change speed of a body pressure measurement means was below a predetermined value, or biomedical signal detection equipment of 11 given in any 1 term.
[Claim 13] The claim 1 equipped with a timer means by which the output signal of a body pressure measurement means clocks the duration below a predetermined value, and a body pressure signal proofreading means to initialize the output of the aforementioned body pressure measurement means when the aforementioned duration passes more than a predetermined time by the aforementioned timer means, or biomedical signal detection equipment of 12 given in any 1 term.
[Claim 14] The claim 1 equipped with a signal composition means to compound the output signal of a body motion measurement means and a body pressure measurement means by the frequency domain, and a calculation means to compute the amount of the

output features of the aforementioned signal composition means, or biomedical signal detection equipment of 13 given in any 1 term.

[Claim 15] the power value of a body motion measurement means [ in / amendment or predetermined frequency / based on the power value of a body pressure measurement means / in / predetermined frequency / in a signal composition means ] / for the power spectrum of the output signal of a body motion measurement means ] -- being based -- the power spectrum of a body pressure measurement means -- an amendment -- the biomedical signal detection equipment according to claim 14 characterized by things

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[Translation done.]

## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates biomedical signals, such as weight, a heart rate, a respiration rate, and a body motion, to non-invasion and no restraining at detection or the equipment displayed, recorded and reported.
[0002]
[Description of the Prior Art] As for this conventional kind of biomedical signal detection equipment, what is indicated by JP,62-164435,A was common. An electrode 4 is connected to the hot line side of the pierced earring type oscillator circuit 3 which used and constituted FET2 on the bed 1, and an electrode 4 and the electrode 5 which intersected perpendicularly are connected to an earth-line side, and this equipment has the composition of detecting change of the oscillation frequency by the additional capacity in the oscillator circuit using the quartz resonator 6 as shown in drawing 19 . After detection and the wave detector 7 furthermore extracted the envelope of the change of frequency based on a living body's change, when the filter 8 removed unnecessary signalling frequencies, such as a noise, it recorded on a recording device 9 or a living body's movement stopped, it was what generates an alarm.
[0003] There are some which are indicated by JP,63-238502,A as other conventional examples. This equipment was what arranges electrodes 11 and 12 in both sides of the pressure-sensitive electrical conductive gum 10 as shown in drawing 20 , and connects an electrode 11 and an electrode 12 to electrostatic volumetry equipment 13 and resistance-measurement equipment 14. That is, it is considered that this is an element which the pressure-sensitive electrical conductive gum 10 becomes from a variable capacitor and variable resistance.
[0004]
[Problem(s) to be Solved by the Invention] However, with conventional biomedical signal detection equipment, it had various technical problems which coil round the electrode composition close to a living body, or a detection method.
[0005] Since only change of the electrostatic capacity produced in inter-electrode is detected, the low frequency signal near a direct current or a direct current cannot distinguish easily whether it is a thing based on a living body's movement.
[0006] Moreover, it is very tended to influence an output signal temperature-and-humidity environment. Moreover, since electrodes 3 and 4 are the configurations of lead wire, a position gap is simply caused on bedding and a living body's movement cannot be detected with sufficient repeatability from change of electrostatic capacity.
[0007] Moreover, when it is easy to disconnect and the source power supply is used at the fold of bedding, or the crossing of an electrode, there is a danger of receiving an electric shock if a living body should be contacted.
[0008] Moreover, if it is going to give the mechanical strength of electrodes 3 and 4 and will do so although a lead wire size must be made fairly thick, it will concentrate on about [ spoiling the feeling of feeling in bed of the sleeping person on a bed (living body) ], and an electrode crossing, and body pressure will be applied, and there is a danger of causing a bedsore.
[0009] Moreover, whether it is on the present bed whether the living body exists does not clarify. It cannot distinguish with the case where a living body dies on the case where a living body separates from on a bed especially, and a bed.
[0010] Moreover, weight is undetectable. Moreover, since the arrangement composition of an electrode is complicated, it is easy to produce performance dispersion at the time of mass-production-izing.
[0011] Since the electrode is not arranged dispersedly at equal intervals, a difference produces it in signal-detectability ability by recumbent form vigor.
[0012] It had the technical problem that initialization of signal level was surely needed before use that the baseline of an output signal tends to be shaken.
[0013] Or when an electrode was lead wire, it had the technical problem that it became an antenna and was very easy to receive a visitor electromagnetic wave noise. It was easy to cause a position gap and also had the technical problem that it was easy to be influenced of visitor oscillating noises other than a living body.
[0014] Among the sensor composition which detects a biomedical signal, generally, an electrostatic-capacity type sensor has the bad temperature characteristic, and a signal is changed in the low frequency region near a direct current. Moreover, the pressure sensitivity type sensor with a pressure-sensitive property of an electrical conductive gum or carbon has a creep property etc., and its speed of response is slow. That is, the accuracy of measurement of absolute pressure is bad, and cannot catch a dynamic RF signal. Although it is distorted as a pressure sensitivity type sensor and there is also a method using a resistance element, an output signal is greatly influenced by environment, such as installation conditions and temperature. As a result, whenever the user

himself was a measurement start, the biomedical signal sensor formed separately the protective device for carrying out zero adjustment and gain regulation, or stabilizing the installation environment of a sensor, or had the technical problem that restrictions of using only as an on-off switch were received until now.
[0015] If it thinks that the resistance stabilized with sufficient repeatability with body pressure will be made to output, you have to use a low impedance conductor. Since it becomes the resistance itself when [ most ] the parallel connection of a resistance element and a capacitor element is considered, and the synthetic impedance has small resistance, even if it uses electrostatic capacitative element together with the same element, measurement of a body motion can be measured with a sufficient precision.
[0016]
[Means for Solving the Problem] The 1st electrostatic capacity formed between the 1st electrode and a living body in order that this invention may solve the above-mentioned technical problem, A body motion measurement means to measure a living body's oscillating signal based on the series-connection electrostatic capacity of the 2nd electrode and the 2nd electrostatic capacity formed among the aforementioned living bodies, It has a body pressure measurement means to measure the body pressure signal accompanying a self-weight of a living body by the 1st or 2nd electrode and 3rd electrode, and has a calculation means to compute characteristic quantity, such as a living body's weight, a heart rate, a respiration rate, an active mass, and a life state, further by the output of a body motion measurement means and a body pressure measurement means.
[0017] According to the above-mentioned invention, the dynamic signal based on living body vibration will be caught by change of electrostatic capacity or a generating charge by the one apparatus sensor using the common-use-ized electrode, and the static signal based on a self-weight of a living body, i.e., body pressure, will be simultaneously regarded as level of resistance or a voltage value. The 1st or 2nd common-use-ized electrode is the reference voltage point (or field) of a signal, and it stops easily being able to receive a visitor electromagnetic wave and an oscillating noise while it can attain simplification of circuitry. With this biomedical signal detection equipment, since a living body's body motion and body pressure are measured simultaneously, incorrect judging of computing a biomedical signal at the time of an absence can be lost. Various kinds of biomedical signals, such as weight which was not obtained with a sufficient precision, a heartbeat, respiration, an active mass, and a life state, can be obtained only from one of the two of a body pressure measurement means and a body motion measurement means with high precision. Moreover, health condition can be judged, without giving the living body itself sense of incongruity in any way by including in the life supply with which living bodies, such as bedding, a carpet, a bathtub, and the seat, touch. Since there are few restrictions to installation environment, it is possible not only a new-building residence but to attach to a facility of existing ****** later simply.
[0018]
[Embodiments of the Invention] A body motion measurement means by which this invention measures a living body's oscillating signal based on the series-connection electrostatic capacity of the 1st electrode, the 1st electrostatic capacity formed among living bodies, and the 2nd electrode and the 2nd electrostatic capacity formed among living bodies, It has a body pressure measurement means to measure the body pressure signal accompanying a self-weight of a living body from a pressure sensitive device, 3rd between the 1st or 2nd electrode and inter-electrode, and has a calculation means to compute a living body's characteristic quantity further by the output of a body motion measurement means and a body pressure measurement means.
[0019] And since a living body's body motion and body pressure are measured using the same electrode, while being able to attain simplification of composition, it is hard coming to receive a visitor electromagnetic wave noise. Moreover, incorrect judging of computing a biomedical signal at the time of an absence can be lost. Since a living body's health condition is judged from the output of both body pressure measurement means and body motion measurement means, various kinds of characteristic quantity, such as weight which was not obtained with a sufficient precision, a heartbeat, respiration, an active mass, and a life state, can be obtained only from one of the two with high precision.
[0020] Moreover, a piezo electric crystal is formed between the 1st electrode and the 2nd electrode, and it has a body pressure measurement means to measure the body pressure signal accompanying a self-weight of a living body by the pressure sensitive device between a body motion measurement means to measure the charge generated by a living body's vibration, the 1st or 2nd electrode, and the 3rd electrode, and has a calculation means to compute a living body's characteristic quantity further by the output of a body motion measurement means and a body pressure measurement means.
[0021] And the vibration level which a living body generates is quantitatively detectable by measuring the charge corresponding to the strain added to the piezo electric crystal. All [ a piezo electric crystal is high impedance material, and / the bad influence to a living body ]. Even if a piezo electric crystal should touch a living body, there is no fear, such as an electric shock. Naturally, no restraining and unconscious measurement are possible for a living body.
[0022] the [ moreover, / for the 1st, the 2nd, and the 3rd electrode being connected to the conductive layer of at least three layers, and each conductive layer, and measuring a living body's body motion or body pressure between the 1st conductive layer and the 2nd conductive layer or between the 2nd conductive layer and the 3rd conductive layer / the 1st or ] -- 2 detection medium layer is formed
[0023] And since the 1st for measuring the electrode and body pressure for measuring a body motion or the 2nd electrode is connected to the conductive layer of ******, it is hard coming to receive the influence of a visitor electromagnetic wave noise. Detectability ability is the same, wherever a living body may be in [ on a conductive layer ], since every position on each conductive layer is ******. Since a detection medium layer is a field-like, the position gap by a living body's movement cannot occur easily, and also has little danger of an open circuit or failure. Sense of incongruity is not given to a living body. Since the arrangement composition of an electrode is still simpler, it is hard to produce performance dispersion at the time of mass-production-izing.

[0024] Moreover, the 1st detection medium layer measures a living body's body motion, and the 2nd detection medium layer measures a living body's body pressure, sticks the 1st and 2nd detection medium layer, and communalizes one side of the electrode connected with one side of the electrode connected to the both-sides side of the 1st detection medium layer in the both-sides side of the 2nd detection medium layer.
[0025] And structure becomes easier and the same position's body motion and body pressure of a living body can be detected simultaneously.
[0026] Moreover, the 1st, the 2nd conductive layer, and a detection medium layer have flexibility, respectively, and come to constitute the really fabricated sensor sheet of ******.
[0027] And since this sensor sheet has flexibility, it can be easily included in the life supply with which living bodies, such as bedding, a carpet, a bathtub, and the seat, touch. And health condition can be judged to the inside of unconscious, without giving the living body itself sense of incongruity in any way. It is easy to carry out processing, and since there are few restrictions to installation environment, it can attach later easily [ a facility of not only a new-building residence but existing ****** ]. Prolonged biomedical signal detection can carry out continuously, without the living body which becomes especially the measuring object interfering with natural life operation of the living body in any way also in the case of bedridden elderly people, dementia elderly people, a physically handicapped person or infants, a pet animal, etc.
[0028] Moreover, a sensor sheet is characterized by having two or more air holes. And by having an air hole, even when a sensor sheet is laid under the bedding etc., metabolism, such as sweating, respiration, etc. of a living body, is not barred.
[0029] Moreover, it is characterized by sticking a waterproofing film inside an air hole. And by constituting a waterproofing film, moisture permeates the interior of a sensor sheet from an air hole, it is hard coming to carry out degradation with the passage of time of the detection sensitivity of a body motion or body pressure, and it can attain high life-ization.
[0030] Moreover, it has a synthetic means to compound the output of the body motion measurement means concerned according to the output of two or more body pressure measurement meanses.
[0031] Since only the output signal of the area where the living body has ridden is extracted as a living body's body motion signal and compounded on a sensor sheet by this, an unnecessary oscillating signal is removed. That is, a S/N ratio improves by leaps and bounds.
[0032] Moreover, between the 1st conductive layer and the 2nd conductive layer, it has the elastic insulating layer from which thickness changes with pressures.
[0033] And if a living body rides on the 1st and 2nd conductive layers, the thickness of an elastic insulating layer will carry out time change by living body vibration generated also in the state of a rest. Since the area of the 1st and 2nd conductive layers and the specific inductive capacity of an elastic insulating layer are fixed, the electrostatic capacity which can be measured between the 1st conductive layer and the 2nd conductive layer serves as a value corresponding to a living body's body motion.
[0034] Moreover, it has the elastic insulating layer with porosity electrically connected with a pressure between the 2nd conductive layer and the 3rd conductive layer.
[0035] And if a living body rides on the 2nd and 3rd conductive layers, the resistance between the 2nd conductive layer and the 3rd conductive layer will serve as a low impedance (flow). Conversely, if a living body separates from on the 2nd and 3rd conductive layers, the resistance between the 2nd conductive layer and the 3rd conductive layer will serve as a high impedance (open circuit). The existence of body pressure can be judged by whether the pressure which balances a self-weight of a living body by this is applied.
[0036] Moreover, it has the pressure-sensitive resistive layer from which resistance changes with pressures, such as an electrical conductive gum and electric conduction carbon, between the 2nd conductive layer and the 3rd conductive layer.
[0037] And a living body's body pressure can be obtained by the pressure-sensitive resistive layer not as the on-off signal made binary but as a continuation value corresponding to weight.
[0038] Moreover, when the output signal or output change speed of a body pressure measurement means is below a predetermined value, it has a body motion signal proofreading means to initialize the output of a body motion measurement means.
[0039] And by the body motion signal proofreading means, even when a living body is absent, the output of a body motion measurement means to change according to aging or temperature-and-humidity environment is stabilized, and a living body's body motion signal can be measured with a more sufficient precision.
[0040] Moreover, when duration passes more than a predetermined time by timer means by which the output signal of a body pressure measurement means clocks the duration below a predetermined value, and the timer means, it has a body pressure signal proofreading means to initialize the output of a body pressure measurement means.
[0041] And a living body's true body pressure signal can be measured by deducting automatically a part for the remainder pressure which exists beforehand when a living body is absent by the body pressure signal proofreading means.
[0042] Moreover, it has a calculation means to compute biomedical signals, such as weight, a heart rate, a respiration rate, and an active mass, from the output of a signal composition means to compound the output signal of a body motion measurement means and a body pressure measurement means by the frequency domain, and a signal composition means.
[0043] Then, the calculation error of a biomedical signal can be reduced by compounding the output of the body motion measurement means which has highly precise output characteristics above predetermined frequency, and the output of the body pressure measurement means which has highly precise output characteristics in the low frequency region near a direct current or a direct current by the frequency domain.
[0044] Moreover, a signal composition means is an amendment thing about the power spectrum of a body pressure measurement

means based on the power value of a body motion measurement means [ in / amendment or predetermined frequency / based on the power value of the body pressure measurement means in predetermined frequency / for the power spectrum of the output signal of a body motion measurement means ].
[0045] Then, the acceleration (or variation-rate, speed) level of living body vibration, such as a living body's activity, and heart stroke, breathing movement, can detect with a precision sufficient as a power value for every frequency.
[0046] The 1st example of this invention is explained using a drawing below.
(Example 1) Drawing 1 is the block diagram of the biomedical signal detection equipment of the example 1 of this invention. Moreover, drawing 2 is the external view of this equipment. Drawing 3 is the important section cross section of this equipment. Drawing 4 is the sensor input circuit view of this equipment.
[0047] In drawing 1 , 15 is a living body, and the sensor sheet with which, as for 16, a living body 15 touches, and 17 are signal processors. The 1st electrode 18, the 2nd electrode 19, and the 3rd electrode 20 are attached in the sensor sheet 16. When a living body 15 rides on this sensor sheet 16, electrostatic capacity C00 is formed between a living body 15 and the 1st electrode 18, and electrostatic capacity C01 is formed between a living body 15 and the 2nd electrode again. That is, between the 1st electrode 18 and the 2nd electrode 19, the compound electrostatic capacity C0 accompanying existence of a living body 15 occurs. Even if a living body 15 furthermore does not exist, when electrostatic capacity C02 is formed between the 1st electrode 18 and the 2nd electrode 19, compound electrostatic capacity C0 is [0048].
[Equation 1]

$$C0=\frac{C00\cdot C01}{(C00+C01)}+C02$$

[0049] It becomes. Moreover, if a living body 15 rides on this sensor sheet 16, the pressure-sensitive switch SW0 is laid underground between the 2nd electrode 19 and the 3rd electrode 20, and it turns on, and it constitutes so that it may turn off, if it separates. A signal processor 17 consists of the body motion measurement means 21, a body pressure measurement means 22, and a calculation means 23. The 1st electrode 18 connected to the sensor sheet 16 and the 2nd electrode 19 are connected to the body motion measurement means 21, and the 2nd electrode 19 and 3rd electrode 20 are connected to the body pressure measurement means 22. The body motion measurement means 21 measures a living body's 15 oscillating signal from time change of electrostatic capacity C0, and the body pressure measurement means 22 judges a living body's 15 body pressure existence. The body motion measurement means 21 and the body pressure measurement means 22 are connected to the calculation means 23. When it judges with the calculation means 23 having body pressure on the sensor sheet 16 from the output of the body pressure measurement means 22, the actual value of the acceleration of vibration based on the output of the body motion measurement means 21 is computed as a living body's 15 active mass.
[0050] The composition of the sensor sheet 16 is explained using drawing 2 and drawing 3 . The 1st electrode 18, the 2nd electrode 19, and the 3rd electrode 20 are connected to the 1st conductive layer 24, the 2nd conductive layer 26, and the 3rd conductive layer 28, respectively. Between the 1st conductive layer 24 and the 2nd conductive layer 26, the elastic insulating layers 25 which have a dielectric, such as rubber and urethane, are inserted. Moreover, between the 2nd conductive layer 26 and the 3rd conductive layer 28, the insulating spacer 27 is arranged in the shape of a dot. The part where the insulating spacer 27 is not arranged forms the opening section. Although it insulates electrically between the 2nd conductive layer 26 and the 3rd conductive layer 28 when a predetermined pressure called for example, more than 1000 [N/m2] is not applied, when the predetermined pressure is applied, it is the pressure-sensitive switch composition which flows electrically. The 1st conductive layer 24 in the sensor sheet 16, the elastic insulating layer 25, the 2nd conductive layer 26, the insulating spacer 27, and the 3rd conductive layer 28 are formed in one, and have flexibility. Moreover, thickness is about 2mm, the bottom of bedding etc. is only covered with this sensor sheet 16, and without having a bad influence on a living body 15 in any way, while it has been unconscious, it can detect a biomedical signal. Moreover, it is also possible to attach in a bed various type [ existing ] later.
[0051] Next, the input circuit composition of the sensor sheet 16 which is in a signal processor 17 using drawing 4 is explained. E0 is supplied to the 2nd electrode 19 which is a common electrode of the body motion measurement means 21 and the body pressure measurement means 22 as reference voltage. The operational amplifier OP1, the fixed resistor R1, and the capacitor C1 are formed in the body motion measurement means 21. When compound electrostatic capacity C0 (t) changes with a living body's 15 body motions, charge Q (t) generated between the 1st electrode 18 and the 2nd electrode 19 is [0052].
[Equation 2]

$$Q(t)=C0(t)\cdot E0$$

[0053] Current I (t) which flows since it becomes the time function to say is [0054].
[Equation 3]

$$I(t)=dQ(t)/dt$$
$$=-V1(t)/R1-C1\cdot dV1(t)/dt$$

[0055] V1 (t) is the output voltage of an operational amplifier OP1 here. Therefore, [0056]
[Equation 4]

$$\frac{dV1(t)}{dt}+\frac{V1(t)}{C1\cdot R1}=\frac{E0}{C1}\cdot\frac{dC0(t)}{dt}$$

[0057] Since the 2nd term of left part can be disregarded if R1 is very large although it comes out, it is [0058].
[Equation 5]
$$V1(t)=E0\cdot C0(t)/C1$$
但しt=0における$V1(t)=0$

[0059] ** -- it can deform like That is, the voltage output V1 (t) proportional to electrostatic capacity C0 (t) will be obtained. Amplifier 21a and A/D-conversion section 21b are connected to this operational amplifier OP1, and the signal of a voltage output V1 (t) is changed by digital value by A/D-conversion section 21b after analog amplification by amplifier 21a. On the other hand in the body pressure measurement means 22, as for the pressure-sensitive switch turned on and off by the existence of body pressure, the series connection of SW0 is carried out to the fixed resistor R2 between the 2nd electrode 19 and the 3rd electrode 20. That is, to the 2nd electrode 19 being always E0 [V], it is set a simultaneously E0 [V] by the 3rd electrode 20 by pressure-sensitive switch SW0 ON, and it is set to about 0 [V] in pressure-sensitive switch SW1 OFF. if the voltage in the 3rd electrode 20 is higher as compared with comparison voltage E0 and R4/(R3+R4) divided by fixed resistors R3 and R4 in this -- a low -- if low, the comparator OP2 is connected so that it may become highness the output of a comparator OP2 -- counting -- it connects with section 22a and body pressure existence judging section 22c, and the existence of body pressure is judged in the total of the highness for a predetermined time, or a low clock 22b -- counting -- the reference clock which performs simultaneously counting of a body pressure signal and A/D conversion of a body motion signal by the pulse which connects with section 22a and A/D-conversion section 21b, for example, is generated every 10ms is generated
[0060] In addition, the noise superimposed on reference voltage E0 or an input signal for explanation simplification was not removed, and the circuitry which stabilizes an input signal by impedance conversion or threshold conversion was not illustrated here. You may constitute and measure an oscillator circuit like the conventional example to measure electrostatic capacity C0 (t). You may have the composition which carries out the differential amplifier only of the deflection with the electrostatic capacity C0 (t) in case the value of C0 in case there is no body pressure is held in order to measure change of the electrostatic capacity C0 (t) in case a living body 15 exists, and there is body pressure. Moreover, it is good also considering reference voltage E0 as a source of alternating voltage. A high-pass filter may be constituted or you may have the composition which cuts an in one direction flowed part and amplifies only an alternating current signal so that the low frequency signal near a direct current may not be detected. Although the 1st conductive layer 24, the elastic insulating layer 25, the 2nd conductive layer 26, the insulating spacer 27, and the 3rd conductive layer 28 were furthermore explained as a film-like sheet, this may really be fabricated in the shape of flexible ] a coaxial cable, and may be arranged to a field to detect, for example.
[0061] (Example 2) Drawing 5 is the important section cross section of the biomedical signal detection equipment of the example 2 of this invention. Drawing 6 is the sensor input circuit view of this equipment. The component which has the same function as an example 1 gives the same number, and omits explanation. A different point from an example 1 in drawing 5 is in the point that the pressure-sensitive resistive layer 29 with uniform thickness, such as not the insulating spacer 27 but conductive rubber, is inserted between the 2nd conductive layer 26 and the 3rd conductive layer 28. The pressure-sensitive resistive layer 29 can be expressed with the variable resistance R0 from which resistance changes with body pressure continuously in drawing 6 . In the 3rd electrode 20, it is [0062].
[Equation 6]
$$V2=E0\cdot R2/(R0+R2)$$

[0063] The voltage V2 according to the becoming body pressure has arisen. 22d is the 2nd A/D-conversion section, and digitizes an analog voltage signal by the pulse in every 10ms given by clock 22b.
[0064] In addition, the air bag which had flexibility in measuring a living body's 15 body pressure instead of the pressure-sensitive resistive layer 29 may be prepared, and the pressure of this air may be measured by the pressure sensor of a diaphragm type.
[0065] (Example 3) Drawing 7 is the important section cross section of the biomedical signal detection equipment of the example 3 of this invention. A different point from an example 2 in drawing 7 is to have arranged [ having coated the sensor sheet 16 upper surface with the waterproofers 30, such as a PET film, and ] to both ends rather than to have covered the sensor sheet 16 whole with the 2nd electrode 26 and 3rd electrode 28.
[0066] Simplification of composition can be attained while the performance degradation by the corrosion of the sensor sheet 16 etc. is lost by this.
[0067] (Example 4) Drawing 8 is the important section cross section of the biomedical signal detection equipment of the example 4 of this invention. A different point from an example 3 in drawing 8 is to have formed [ having coated the sensor sheet 16 whole with the waterproofers 30, such as a PET film, and ] many air holes 31. While being able to plan aeration of the 16 sensor sheet side by this, the corrosion of each conductive layer is lost. Even when the sensor sheet 16 is laid under the bedding etc., metabolism, such as sweating, respiration, etc. of a living body 15, is not barred.
[0068] (Example 5) Drawing 9 is important section structural drawing of the biomedical signal detection equipment of the example 5 of this invention. Drawing 10 is the block diagram of this equipment. A different point from an example 4 in drawing 9 is to have prepared the sensor sheet classified by [ of 18 sheets ] area (16a, 16b, 16c, ...) which carried out independent arrangement into the sensor sheet 16 at the shape of a two dimensional array. The 2nd electrode 19 (19a, 19b, 19c) is altogether connected to the equal reference voltage E0 here. although the output of the pressure-sensitive resistive layer 29 of each sensor

sheet classified by area can be expressed with variable resistance R0 (R01, R02, R03, ...) in equivalent -- this output -- responding -- each body pressure switch 32 (32a --) If more than a predetermined pressure is detectable by 32b, 32c, and ..., it will be the composition which connects the 1st electrode 18 (18a, 18b, 18c, ...) which takes out the output signal of the compound electrostatic capacity C0 (C01, C02, C03, ...) for measuring a body motion, otherwise, is not connected. The output of each body pressure switch 32 (32a, 32b, 32c, ...) is added with the measurement-of-body-weight means 33, and is told to the calculation means 23 as digital value equivalent to a living body's 15 weight. On the other hand, parallel connection only of what was connected by the body pressure switch 32 among the 1st electrode 18 (18a, 18b, 18c, ...) is carried out to the body motion measurement means 21, and it is inputted. That is, electrostatic-capacity C0act connected to the body motion measurement means 21 is [0069].

[Equation 7]

$$C0act=\sum_{i=1}^{18}(C0i\cdot Ki)$$

[0070]

[Equation 8]

$$ki=\begin{cases}1, & \text{if } R0i<Rref\\ 0, & \text{if } R0i\geq Rref\end{cases}$$

ここでRrefは一定、i=1～18

[0071] It can come out and express. even if a living body 15 rides on the sensor sheet 16 -- recumbent form vigor -- sleeping -- a position -- each sensor sheet classified by area (16a, 16b, 16c, ...) -- neither body pressure nor a body motion is added equally altogether Moreover, irregularity is in a living body's 15 configuration itself, and a body motion can detect effectively from the area by which body pressure is generally applied. Because, since it is separated [ from the area which has not required body pressure ] of the distance of the sensor sheet 16 with the living body 15, change of the electrostatic capacity by the body motion is also slight. If all the 1st electrode is connected to carrying out a living body's 15 body motion with the body motion measurement means 21, since the compound electrostatic capacity C0 from the first is large, the ratio of change of the same body motion of C0 will become small relatively. On the other hand, if change of the compound electrostatic capacity Cact of only the area which has required body pressure is detected as a body motion, ******, as a result the S/N ratio of a body motion signal can be raised.

[0072] In addition, although considered as length width [ of six lines ] 3 train here, a spatial resolving power is not restricted to this. Moreover, you may make it one-dimensional array.

[0073] (Example 6) Drawing 11 is the block diagram of the biomedical signal detection equipment of the example 6 of this invention. Drawing 12 is the output frequency property view of a piezo electric crystal. A different point from an example 5 in drawing 11 is in the point that the elastic insulating layers 25 which have a dielectric, such as rubber and urethane, are not inserted, and the piezo-electric-crystal layer of the shape of a film, such as a polyvinylidene fluoride, is inserted between the 1st conductive layer 24 and the 2nd conductive layer 26. A piezo-electric-crystal layer is the element which generates electric polarization (charge) according to added distortion, and it is used in order to measure dynamic movement called mechanical vibration. drawing 11 differs from drawing 10 -- the 1st electrode 18 (18a, 18b, and 18c --) The oscillating radiators X01, X02, and X03 which showed not a capacitor but the piezo-electric-crystal layer in equivalent between ... and the 2nd electrode 19 (19a, 19b, 19c, ...), and the point equipped with ..., It is in the point equipped with the amplification means 34 which carries out signal amplification after compounding the output of the piezo-electric-crystal layer of the area which body pressure has required. It has an automatic amplification factor control (AGC) mechanism so that impedance conversion of it may be carried out by FET in order that the amplification means 34 may take out effectively the signal of a piezo electric crystal with a high output impedance, and the output voltage after amplification may not be saturated, and the always optimal dynamic range is obtained. Although a piezo electric crystal has stable output characteristics below with constant temperature, it is an element with the differential type characteristic to which the output gain of the low-frequency component near a direct current falls under the influence of the quality of the material, a configuration, the input impedance of a detector, etc. as shown in drawing 12 . In addition, you may use a charge amp advantageous to minute oscillating detection for the amplification means 34.

[0074] Since the foreign oscillating noises (for example, an automobile, a train or an unfelt earthquake, a wind, etc.) produced in the area which body pressure has not required by the above-mentioned composition are excludable, the S/N ratio of a body motion signal can be raised.

[0075] (Example 7) Drawing 13 is the block diagram of the biomedical signal detection equipment of the example 7 of this invention. Drawing 14 is a graph which shows the resistance of the pressure-sensitive resistive layer 29, body pressure, and an amplification factor. A different point from an example 6 in drawing 13 is a point of having prepared the body pressure measurement meanses 35a, 35b, and 35c and ... which measure the size of body pressure for every area, and having prepared amplification meanses 36a, 36b, and 36c to change an amplification factor continuously according to the size of the body pressure for every area, and ... According to the property of an element, resistance R0of pressure-sensitive resistive layer 29 i [omega] (i=1-18) is changed into body pressure Pi [N/m2] like drawing 14 (a), and nonlinear conversion is carried out still like drawing 14 (b) at an amplification factor Gi. Furthermore, the absolute value-ized meanses 37a, 37b, and 37c and ... are connected to each amplification meanses 36a, 36b, and 36c and ... The absolute-value-ized signal is added to a body motion measurement means.

[0076] Since the signal from the piezo-electric-crystal layer of all area is not called open circuit by the above-mentioned composition but weighting is carried out for every area as a function of the smooth and continuous body pressure according to

body pressure if it is connection and the following if it is more than predetermined body pressure like an example 5, un-arranging [ from which an output signal changes / a living body 15 / a lot discontinuously only by / mere / moving for a while ] is lost.
[0077] Moreover, since it is compounding once it absolute-value-izes the body motion signal for every area, a signal can be enlarged. Although signals may deny and suit if time difference, i.e., a phase shift, is according to a living body part and it compounds simply, although the periodic living body vibration by the heart stroke, the blood flow, etc. has arisen from the living body front face when the living body 15 is making it the rest, the S/N ratio of the signal acquired by preparing such absolute value-ized meanses 37a, 37b, and 37c and ... can be kept large.
[0078] (Example 8) Drawing 15 is the block diagram of the biomedical signal detection equipment of the example 8 of this invention. the output of the body pressure measurement means 22 connects to the body motion signal proofreading means 38 and the timer means 39 the point that drawing 15 differs from an example 1 -- having -- further -- the timer means 39 -- the body pressure signal proofreading means 40 -- minding -- the body pressure measurement means 22 -- or it is the point that the body motion signal proofreading 38 is connected to the body motion measurement means 21 With [ the output from the body pressure measurement means 22 ] 1000 [ below ] [N/m2], the body motion signal proofreading means 38 considers that a living body 15 does not exist, and it carries out a zero point adjustment, applying bias so that the output from the body motion measurement means 21 may become the smallest. Similarly, with the timer means 39, for example with [ the output from the body pressure measurement means 22 ] 1000 [ below ] [N/m2], it considers that a living body 15 does not exist and the duration of the same body pressure is clocked. If this state continues, for example for 10 minutes, zero adjustment will be carried out applying bias so that the output of the body pressure measurement means 22 may be set to 0.0 [N/m2] by the body pressure signal proofreading means 40. if the value of body pressure is changed within 10 minutes, ** the timer means 39 will clear a time check -- body pressure -- more than 1000 [N/m2] -- a time check -- it is the composition of forbidding the very thing Although it is dependent also on the sensor sensitivity of the body pressure measurement means 22, a living body 15 is not considered to stand it still completely as long as life activity is being carried out. Therefore, by establishing the body pressure signal proofreading means 40 which carries out the zero point adjustment of the output of the body pressure measurement means 22, the weight of discard, such as a futon, a bolster, etc. which were on the sensor sheet 16 from the start, is cancellable. Even when the same weight or the output resistance value changes with creep properties of a pressure-sensitive resistance element etc., a body pressure signal can be certainly regarded as a difference when changing from an absent state to ******. This is convenient although a living body's 15 weight etc. is measured with a sufficient precision. Moreover, by establishing the body motion signal proofreading means 38 which carries out the zero point adjustment of the output of the body motion measurement means 21, this appearance of the baseline produced by the background vibration continuously generated although a living body 15 does not exist, change of temperature-and-humidity environment, etc. can be negated automatically. It becomes possible to detect only a living body's 15 body motion signal effectively from the moment the living body 15 changed to ** from the absence by this.
[0079] (Example 9) Drawing 16 is the block diagram of the biomedical signal detection equipment of the example 9 of this invention. The power spectrum acquired when there is a living body 15 on the sensor sheet 16 by the rest supine position as for drawing 17 , and drawing 18 are drawings having shown the synthetic ratio of the body motion measurement means 21 and the body pressure measurement means 22. The point that drawing 16 differs from an example 1 is a point that the output of the body motion measurement means 21 is expressed with the 1st frequency-conversion means 41, the output of the body pressure measurement means 22 as a power spectrum on a frequency shaft is expressed as a power spectrum on a frequency shaft with the 2nd frequency-conversion means 42, and both are compounded as one power spectrum with the power spectrum composition means 43. The power spectrum composition means 43 is connected to the display means 47 with the measurement-of-body-weight means 33 which was connected to the heart rate calculation means 44, the respiration rate calculation means 45, and the active-mass calculation means 46, and was further connected to the body pressure measurement means 22. With the display means 47, the present living body's 15 heart rate, a respiration rate, an active mass, and weight are displayed and accumulated. Although the graph of a power spectrum as shown in drawing 17 can be obtained from the 1st frequency-conversion means 41 or the 2nd frequency-conversion means 42, the power spectrum of the 1st frequency-conversion means 41 which can acquire a highly precise signal by a direct current or low frequency, and the power spectrum of the 2nd frequency-conversion means 42 which can acquire the signal highly precise than predetermined frequency in a RF region are composition summarized to one power spectrum by the synthetic ratio as shown in drawing 18 . In the about 0.2Hz peak fresp, in drawing 17 , respiratory frequency and the about 1Hz peak fhr show heartbeat frequency. Moreover, the power integrated value (area) in 0.1Hz to 10Hz shall define an active mass. In order to compute a heart rate and a respiration rate with the heart rate calculation means 44 or the respiration rate calculation means 45, it converts into a heart rate or a respiration rate by discovering the peak point in a predetermined-frequency band (a heart rate being 0.5Hz - 2.0Hz, and a respiration rate being 0.05Hz - 0.4Hz), respectively. Furthermore, the unusual information means 48 is connected to the display means 47. It is in a state with a living body's 15 body pressure, and life activity is the composition of emitting an alarm tone and reporting emergency, when the case where a halt or an active mass becomes below predetermined level, a heart rate, and a respiration rate deviate from the predetermined range. The unusual information means 48 is combined with a timer, and judges the accident of condition or health condition from a long-term trend change, and you may make it emit warning. You may accumulate and display the strength of not only the value of a heart rate or a respiration rate but the heart stroke, or breathing movement as a power value in the peak frequency point concerned. Moreover, about a heart rate and the derivation of respiration rate, since the wave accompanying the heart stroke or breathing movement is not an ideal sine wave, the higher harmonic of fundamental frequency stands in many cases. In order to prevent miscalculation appearance, cepstrum conversion may be carried out further, and you may use the method of extracting only a fundamental wave and deleting a double-precision frequency point out of the candidate of a peak point. The 1st

frequency-conversion means 41 or the 2nd frequency-conversion means 42 carries out frequency conversion of the time series signal for for 1 minute sampled by 200Hz of sampling frequencies with staggering one by one every 5 seconds here. In a rest state, since it is hard to think, that a heart rate and a respiration rate change suddenly to more than double precision and 1/2 or less may specify a heart rate and a derivation-of-respiration-rate frequency band (movable range) in adaptation based on the last calculation result. In order to separate the heart stroke and breathing movement containing the R wave component of the shape of a comparatively steep pulse, you may cover a filter beforehand. After compounding by the shape of a frequency shaft and returning in the shape of a time-axis, you may compute a heart rate, a respiration rate, an active mass, etc.
[0080] Moreover, for compounding two power spectrums, the average of specific frequency, for example, the power value in 1Hz, may be made into a reference point, and the frequency band beyond it may compound the power spectrum of the 1st frequency-conversion means 41, and the frequency band below it by a slide or the linear transform based on the power spectrum of the 2nd frequency-conversion means 42.
[0081] The biomedical signal detection which harnessed the advantage of two kinds of sensors built in the same sensor sheet 16 by this, and existed is attained, and can reduce the influence to visitor noises, such as temperature-and-humidity environment, and background vibration, an electromagnetic wave.
[0082]
[Effect of the Invention] According to the biomedical signal detection equipment of this invention, the following effect is acquired so that clearly from the above explanation.
[0083] (1) Since the electrode for body motion measurement and body pressure measurement is common-use-ized, while being able to attain simplification of composition, it is hard coming to receive a visitor electromagnetic wave and an oscillating noise. Moreover, since the biomedical signal is detected from two kinds of sensor outputs, at the time of an absence, incorrect judging of computing a biomedical signal can be lost and various kinds of biomedical signals, such as weight, a heartbeat, breathing, an active mass, and a life state, can be obtained with high precision.
[0084] (2) Since the piezo electric crystal is used for body motion measurement, the unconscious measurement [ all / measurement ] is possible for the bad influence to a living body. Even if a piezo electric crystal should touch a living body, there is no fear, such as an electric shock. Naturally, no restraining and unconscious measurement are possible for a living body.
[0085] (3) Since each electrode is connected to the conductive layer of ******, detectability ability is the same wherever a living body may be in [ on a conductive layer ]. The position gap by a living body's movement cannot occur easily, and also has little danger of failure. Since the arrangement composition of an electrode is simple, it is hard to produce performance dispersion at the time of mass-production-izing.
[0086] (4) Since two kinds of detection medium layers were stuck without the conductive layer and it has detected, structure becomes easier and the same position's body motion and body pressure of a living body can be detected simultaneously.
[0087] (5) Since the flexible sensor sheet was prepared, it is possible to include in the life supply with which living bodies, such as bedding, a carpet, a bathtub, and the seat, touch easily. It is easy to carry out processing, and since there are few restrictions to installation environment, it can attach later easily [ a facility of not only a new-building residence but existing ****** ]. Prolonged biomedical signal detection can carry out continuously, without the living body which becomes especially the measuring object interfering with natural life operation of the living body in any way also in the case of bedridden elderly people, dementia elderly people, a physically handicapped person or infants, a pet animal, etc.
[0088] (6) Since it has two or more air holes, even when a sensor sheet is laid under the bedding etc., don't bar metabolism, such as sweating, breathing, etc. of a living body.
[0089] (7) since the waterproofing film was prepared -- detection sensitivity -- passing -- the time -- deteriorating -- being hard -- high life-ization can be attained
[0090] (8) Since the effective biomedical signal of the area where two or more sensor sheets are prepared, and a living body exists can be taken out alternatively, an unnecessary oscillating signal is removed and a S/N ratio improves by leaps and bounds.
[0091] (9) With an elastic insulator, the electrostatic capacity corresponding to a living body's body motion can be obtained.
[0092] (10) With an elastic insulator with porosity, the existence of body pressure corresponding to a self-weight of a living body can be judged.
[0093] (11) By the pressure-sensitive resistive layer, a living body's body pressure can be obtained as a continuation value corresponding to weight.
[0094] (12) By the body motion signal proofreading means, it can measure with a sufficient precision also to aging or temperature-and-humidity environment.
[0095] (13) By the body pressure signal proofreading means, a living body's true body pressure signal can be measured.
(14) The calculation error of a biomedical signal can be reduced by compounding the output of a body motion measurement means, and the output of a body pressure measurement means by the frequency domain.
[0096] (15) the power spectrum of a body motion measurement means, and the power spectrum of a body pressure measurement means -- an amendment -- by things, a living body's periodic vibration can detect with a precision sufficient as a power value for every frequency

[Translation done.]

* NOTICES *



## DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block diagram of the biomedical signal detection equipment of the example 1 of this invention
[Drawing 2] The external view of the biomedical signal detection equipment of this example
[Drawing 3] The important section cross section of the biomedical signal detection equipment of this example
[Drawing 4] The sensor input circuit view of the biomedical signal detection equipment of this example
[Drawing 5] The important section cross section of the biomedical signal detection equipment of the example 2 of this invention
[Drawing 6] The sensor input circuit view of the biomedical signal detection equipment of this example
[Drawing 7] The important section cross section of the biomedical signal detection equipment of the example 3 of this invention
[Drawing 8] The important section cross section of the biomedical signal detection equipment of the example 4 of this invention
[Drawing 9] Important section structural drawing of the biomedical signal detection equipment of the example 5 of this invention
[Drawing 10] The block diagram of the biomedical signal detection equipment of this example
[Drawing 11] The block diagram of the biomedical signal detection equipment of the example 6 of this invention
[Drawing 12] The output frequency property view of the piezo electric crystal of this example
[Drawing 13] The block diagram of the biomedical signal detection equipment of the example 7 of this invention
[Drawing 14] (a) The graph which shows the resistance and body pressure of the pressure-sensitive resistive layer 29 in this example
(b) The graph which shows the amplification factor and body pressure of the pressure-sensitive resistive layer 29 in this example
[Drawing 15] The block diagram of the biomedical signal detection equipment of the example 8 of this invention
[Drawing 16] The block diagram of the biomedical signal detection equipment of the example 9 of this invention
[Drawing 17] Drawing showing the power spectrum of the biomedical signal of this example
[Drawing 18] Drawing having shown the synthetic ratio of the body motion measurement means 21 and the body pressure measurement means 22
[Drawing 19] Drawing showing conventional electrostatic-capacity type biomedical signal detection equipment
[Drawing 20] Drawing showing other biomedical signal detection equipments which used together a conventional electrostatic-capacity type and a conventional pressure sensitivity type
[Description of Notations]
15 Living Body
16 Sensor Sheet
17 Signal Processor
18 1st Electrode
19 2nd Electrode
20 3rd Electrode
21 Body Motion Measurement Means
22 Body Pressure Measurement Means
23 Calculation Means
24 1st Conductive Layer
25 Elastic Insulating Layer
26 2nd Conductive Layer
27 Insulating Spacer
28 3rd Conductive Layer
29 Pressure-sensitive Resistive Layer
30 Waterproofer
31 Air Hole
32 Body Pressure Switch
33 Measurement-of-Body-Weight Means
35 Body Pressure Measurement Means
38 Body Motion Signal Proofreading Means
39 Timer Means
40 Body Pressure Signal Proofreading Means

41 1st Frequency-Conversion Means
42 2nd Frequency-Conversion Means
43 Power Spectrum Composition Means
44 Heart Rate Calculation Means
45 Respiration Rate Calculation Means
46 Active-Mass Calculation Means

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[Translation done.]